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Z-Drive for a Watercraft

Technical Field

The invention relates to a Z-drive for a watercraft as specified in the preamble of the first Claim.

Prior Art

Variation of the immersion depth of propellers, a critical component of the travel speed of a watercraft when planing, is achieved by a variety of methods.
For example, in the case of surface-propeller drive units having a rigid propeller shaft, as specified in US 4,746,314, this is achieved by the craft's speed, whereby hydroplaning of the hull changes when transitioning from displacement travel to planing travel, that is, at slow speed the propeller is thus situated in a fully submerged state, while when planing it is situated in a partially submerged state.

In addition, US 4,645,463 and US 5,666,415 disclose surface drive units in which the immersion depth of the propeller is achieved by trimming the propeller shaft – with the disadvantage that the propeller, or hull, necessarily occupies a possibly undesirable trim angle.

US 4,371,350 similarly discloses a method whereby a flap valve on the watercraft is used to control the water flow, and thus the immersion depth of the propeller – with the disadvantage of a rigid propeller shaft.
Also known, especially for outboard drive units, are means – usually offered as accessory equipment – by which the propellers operate fully submerged at low speeds, while at high travel speeds they can be manually raised to a partially submerged mode by vertically lifting the entire outboard unit by means of an electrohydraulic system.
In the case of widely available Z-drives, trimming can also be used to change the height of the propeller theoretically be a few centimeters – however, at the same time the propeller trim is changed in an unfavorable manner.

Description of the Invention

The goal of the invention is to avoid the disadvantages of the prior art in a Z-drive for a watercraft of the species referenced above, while presenting a method whereby in Z-drives specifically the propeller immersion depth, that is, the height adjustment of the propeller relative to the craft's hull, or the water immersion depth, can be set for different states of the craft, yet independently of the trim of the Z-drives.

According to the invention, this goal is achieved by the features of the first claim.

The core of the invention is an intermediate piece which provides the immersion depth of the propeller by swiveling the drive unit, while independently therefrom also reliably providing the standard trim for the Z-drive.

The advantage of the invention consists in the simple implementability and simple introduction of a means of this type into the Z-drive system. The intermediate piece is

located in compact form between the Z-drive bell-housing and the Z-drive itself, and contains the pivoting device for the Z-drive, the electrical or hydraulic drive unit, the associated optional angle transmitter, and the bracket of the trim cylinder(s).
The intermediate piece further comprises an intermediate housing which is attached to the bell-housing, or may be implemented as an integrated component of the bell housing.
The Z-drive thus dispenses with the trim cylinder; this may now be fabricated in a short-shaft or short-stroke design, whereby in order to reliably raise the Z-drive, for example, in shallow waters, this component is now pivoted away from the danger zone laterally by a pivot motor.

Additional advantageous embodiments of the invention are found in the subclaims.

Brief Description of the Drawings

The following discussion explains embodiments of the invention in more detail based on the drawings. Identical elements in the various figures are provided with identical reference notations.

Figure 1 is a schematic rear view of the Z-drive according to the invention, with laterally pivotable kinematics and a possible immersion depth position, indicated by the broken lines;

Figure 2 is a schematic side view of a Z-drive and possible trim position, indicated by the broken lines;

Figure 3 is a schematic cross-section in the area of the intermediate piece;

Figure 4 is a plan view of a watercraft according to the invention.

Only those elements essential to the immediate understanding of the invention are shown. Not shown are, specifically, seals, drive shafts with associate bearings, oil, cooling water and exhaust gas ductings from the Z-drive to the motor.

Means of Implementing the Invention

Figure 1 is a is a schematic rear view of the Z-drive 30 which comprises a Z transmission upper section 2, a Z transmission lower section 3, and a propeller 4, and which is radially pivotably flange-mounted to an intermediate piece 1 including an integrated pivot motor 5 and a trim cylinder 6. The possible radial pivoting of Z-drive 30 is demonstrated by the broken line; the immersion depth of the propeller in the water is represented by the waterline X.

Figure 2 is a schematic side view of Z-drive 30, wherein intermediate piece 1 is located between the Z-drive and a bell-housing 7. Bell-housing 7 is retained by a cardan housing 8, and enables bell-housing 7 and the components located behind it to rotate about the axis A perpendicular to the plane of the drawing, and simultaneously about the axis B to control Z-drive 30 so as to effect a rudder function. The rotational motion about axis A is provided by trim cylinder 6 which is supported by intermediate piece 1 and cardan housing 8. The immersion depth of the propeller in the water is represented by the waterline X.

Figure 3 shows a schematic cross-section in the area of intermediate piece 1. Intermediate piece 1 comprises an intermediate housing 24, an inner pivot tube 10, bearings 12, tube bracket 13, and the pivot motor 5. In this view, only the upper transmission section 2 of Z-drive 30 is shown, which transmission section is fixedly fastened by bolts 9a to the rotatably mounted to the inner pivot tube 10. Inner pivot tube 10 has at one location a shoulder 11 which is supported by axial bearing 12 against intermediate housing 24 and a tube bracket 13, whereby tube bracket 13 additionally prevents any axial shift of inner pivot tube 10, and thus enables the bearing clearance to be adjusted as well. Tube bracket 13 and/or intermediate housing 24 also have at least one radial bearing 14 providing low-friction pivoting for inner pivot tube 10, or Z-drive 30.

On shoulder 11 is mounted a gear ring 15 which is able to be put into motion by a pinion 16. Pinion 16 is driven by pivot motor 5 which may be driven either electrically or hydraulically. Appropriate gear pairs, for example, worm gears or other means may be used to implement the pivot mechanism in self-locking form. Hydraulic or electrical lines 17 are extended from intermediate piece 1 into the interior of the watercraft. As an option, an angle transmitter 18 may be installed in intermediate piece 1, which transmitter may be connected to pinion 16, pivot motor 5, shoulder 11, or other components not shown, thereby indicating the exact position of propeller 4. A flexible cable 19 is used to route angle transmitter 18 from within intermediate piece 1 into the watercraft, thereby providing a display or a value for the algorithm used to control the propeller position or the watercraft.

Intermediate housing 24 is fastend by bolts 9b to bell-housing 7. Intermediate housing 24 may also be integrated into bell-housing 7, specifically, in a single-piece design. Bell-housing 7 is connected to cardan housing 8 by being pivotably mounted at site A, which in turn is pivotably mounted at site B, for example, to a support housing not

shown, or directly to the hull of the watercraft. Intermediate piece 1 is connected by intermediate housing 24 through trim cylinder 6 to cardan housing 8, thus enabling Z-drive 30 to be raised for trimming. Most Z-drives have a trim sensor which is integrated at site A, and can thus be retained.
Also shown schematically are transmission gears 20 and a shaft 21 which passes through inner pivot tube 10, intermediate housing 24, bell-housing 7, and is connected to motor shaft 22, a not-shown cardan joint being located at site A to provide the diffraction angle for the shaft – through pivot A when trimming, and through pivot B when steering.

In addition, a separate line 23 is shown schematically which is intended to represent the lines for oil, cooling water, blade adjustment for an adjustable propeller, or coupling and exhaust-gas ducting.

Swiss patent application no. 2002 2041/02, the disclosure of which is herewith incorporated by reference, shows laterally pivotable drive units which enable, with little complexity/expense, to combine the advantages of propeller immersion depth with propeller trimming in one integrated housing.

Figure 4 illustrates a watercraft 31, having a hull 32, drive unit 30, and associated propeller 4. The motor located in the stern of watercraft 31 is not shown. The motor is connected by a shaft, also not shown, to drive unit 30 which is located at stern side 35 of hull 32, and which may have, for example, multiple shafts and bevel gear pairs. An example of an operating position for propeller 4 is shown on the right-hand side of Figure 4. On the left-hand side, the propeller is shown pivoted laterally upward such that the propeller comes to rest at least partially in the area of a water intake 36 located on or in

hull 32, and having a water intake opening 37 and water outlet opening 38.
The pivoting of propeller 34 may be triggered either manually or automatically by a specific event. The pilot may, for example, set various pivot positions as desired by a switch on the controls, or pivoting can be implemented by electronic controls which respond to different parameters, for example, the water depth, speed of the motor, etc.

The water intake 36 to provide the appropriate flow to the propeller may be located on the lateral side of the boat in the form of closed channel in the hull, as illustrated on the right-hand side of Figure 4, or as a cut-out section, as shown on the left-hand side of Figure 4, which is located in the hull of the watercraft in order to provide the appropriate flow to the propeller. Water intake 36, or water intake opening 38, may be either open of closed, that is, appropriate flap valves cover the water inlet opening when not in use, or such flap valves are not present at all, as is the case for the cut-out section in the hull of the watercraft, shown on the left in Figure 4.

Use of the radially pivotable drive unit 30, and thus propeller 4, provides for a space-saving underwater drive unit having an unchanged thrust direction for the propeller in any pivot position. Thus, in the case of shallow water, drive unit 30 may be pivoted laterally until it reaches the level of water intake 36. The water required for propeller thrust is thus no longer taken in below the hull of the watercraft, but instead essentially behind and protected by stern side 35 of watercraft 31, such that travel may be continued at locations which would otherwise be impassable for watercraft with a Z-drive due to the shallow water.
The water intake thus has advantages and power output analogous to that of a jet drive system. An additional advantage is the fact that the propeller is protected from striking the bottom, while also allowing eelgrass to be easily removed from the open propeller region – for example, by laterally moving the drive unit further upward until drive unit 30 and propeller 4 actually emerge above the surface of the water.

Drive unit 30 together with the propeller may additionally be designed to pivot longitudinally, that is, in the longitudinally / in the direction of the watercraft's axis. This

longitudinal pivoting by a few degrees of angle, also known as trimming, helps keep the bow of the watercraft steady in rough water, or to make it faster.

The invention solves the problem of a large space requirement at the stern of the watercraft. While Z-drives do not have the space problem in the cockpit, the thrust angle change, as well as the additional space requirement at the stern when the drive unit is swung upward, remain.

The function whereby the underwater drive unit can be pivoted through a large angular zone without loss of power permits the propeller also to be operated as a surface-propeller drive unit, that is, when underway the propeller is only partially submerged when used, and may be employed in high-speed watercraft.
For this purpose, a modified section is employed which is located above the waterline during planing, and to the end of which is attached the pivoting component for the underwater drive unit.

In the pivoted-up position, the water intake or opening to the propeller may be either open or closed, that is, appropriate flaps valves cover the water inlet when not in use; or such flaps are not even present, but instead a cutout is located in the hull of the watercraft providing a suitable means of flow to the propeller. The water intake opening may be located on the lateral side or within the bottom region of the watercraft, as governed by the power input of the drive unit.

It is understood that the invention is not limited to the embodiment shown and described here.

List of reference notations

1	intermediate housing[1]
2	upper transmission section
3	lower transmission section
4	propeller
5	pivot motor
6	trim cylinder
7	bell-housing
8	cardan housing
9a	bolts from 2 to 10
9b	bolts from 1 to 27
10	inner pivot tube
11	shoulder
12	axial bearing
13	tube bracket
14	radial bearing
15	gear ring
16	pinion
17	lines
18	angle transmitter
19	cable
20	transmission gears
21	shaft
22	motor shaft
23	separate line

[1] Translator's note: reference number also applied to "intermediate piece."

24 intermediate housing
30 Z-drive
31 watercraft
32 hull
35 stern side
36 water intake
37 water intake opening
38 water outlet opening

A trim axis
B steering axis
X waterline